Department of Atmospheric Science

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Undergraduate
No undergraduate major is offered. Undergraduates interested in atmospheric science at the graduate level are encouraged to major in engineering, physics, chemistry, mathematics, or atmospheric science.

Graduate
Graduate Programs in Atmospheric Science
The department offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees in Atmospheric Science. Since the graduate degrees are primarily research degrees, the specialization opportunities for students generally reflect the research interests and expertise of the academic faculty. The academic curriculum and research training for atmospheric science graduate students are closely integrated. Graduates of the program typically find employment in government research laboratories, academic institutions, military services, and private industry. Students with a baccalaureate degree in mathematics, the natural sciences, or engineering are recommended to apply for admission.

For additional information on graduate programs and the application process, please visit the Department of Atmospheric Science (http://atmos.colostate.edu/dept/research.php) website, Application Overview (http://www.atmos.colostate.edu/gradprog/admission.php), and Atmospheric Science Graduate Student Guide (http://www.atmos.colostate.edu/gradprog/graduateGuide/toc.php).

M.S. Program
Students that complete the M.S. program will have acquired the knowledge and proficiency needed to seek employment in the field of atmospheric science. This knowledge and proficiency are gained through completion of a required core curriculum, elective graduate courses chosen from a wide selection of offerings, and by participation in scientific research with their advisors.

M.S. graduates are prepared for a wide choice of professionally satisfying work in private industry, the consulting field, and with many government agencies. Graduates of the M.S. program can also choose to continue their studies and research in the Ph.D. program.

A student is eligible to seek admission to the Ph.D. program after successfully completing a thesis-based M.S. degree with a positive recommendation from their M.S. committee. Students holding thesis-based M.S. degrees from institutions other than CSU may be directly admitted into the Ph.D. program. These students follow the normal application procedures to our program.

In addition to meeting the formal credit requirements for the M.S., described below, all graduate students enrolled in the department are expected to attend the weekly department colloquium series. These colloquia are an important part of the total instructional program. Details can be found on the colloquium page (http://www.atmos.colostate.edu/dept/colloquia.php) on the ATS website.

Prerequisites
- Bachelor of Science (B.S.) degree in physics, math, atmospheric science, engineering, chemistry, or related field with a cumulative GPA of at least 3.0
- Calculus-based math course sequence including differential equations and vector analysis
- Calculus-based physics course sequence including kinetics, electricity and magnetism, and some modern topics

Plan A (Thesis)
A minimum of 30 semester credits plus thesis is required. At least 24 credits must be earned in structured academic courses. Six credits may be in special studies, graduate seminars, and research (a maximum of six research credits is allowed). Of the total 30 credits, 20 must be Department of Atmospheric Science courses (i.e., courses with the ATS prefix).

All MS students must complete the following required courses (required courses account for 18 credit hours):
- ATS 601 Atmospheric Dynamics I (3 credits)
- ATS 606 Introduction to Climate (3 credits)
- ATS 620 Thermodynamics and cloud physics (3 credits)
- ATS 621 Atmospheric Chemistry (2 credits)
- ATS 622 Atmospheric Radiation (3 credits)
- ATS 693 Responsible Research in Atmospheric Science (1 credit)
- One of the following:
  - ATS 640 Introduction to synoptic dynamics (3 credits)
  - ATS 641 Introduction to mesoscale dynamics (3 credits)

All MS students must also complete 6 elective credit hours in structured classes. Electives may include any structured class at the 500/600 level. With written advisor approval, electives may also include structured 700 level classes and/or structured graduate courses in other departments. Audits do not count towards the MS degree.

A student may substitute a required class for an alternative course if:
1. A course is similar to the required class has already been completed at the graduate level with a grade of B or higher
2. The student’s advisor, the department head, and the instructor of the required course approve the substitution in writing.

A student’s program of study, and any deviations therein from department degree requirements, requires department head approval.
ATS 784 does not count toward the 24 structured credits. ATS 699A-O and ATS 784 are graded as S/U.

**Ph.D. Program**

The department offers a Ph.D. program for students who want to obtain the highest academic degree available in the field of atmospheric science. Students who earn a Ph.D. must demonstrate significant intellectual achievement, high scholarly ability, and a great breadth of knowledge.

In addition to meeting the formal credit requirements for the Ph.D., described below, all graduate students enrolled in the department are expected to attend the weekly department colloquium series. These colloquia are an important part of the total instructional program. Details can be found on the colloquium page (http://www.atmos.colostate.edu/dept/colloquia.php) on the ATS website.

**Prerequisites**

- Successful completion of an M.S. degree with thesis in atmospheric science, physics, math, engineering, chemistry, or related field
- Demonstration of aptitude for research
- Successful completion of the department preliminary exam that includes background, methods, and current research that applies to the specific area(s) encompassing the candidate’s proposed research topic

**Course Requirements**

- Ph.D. students must take a minimum of 42 semester credits beyond the (thesis option) master’s degree (or 72 semester credits beyond the bachelor’s degree). At least 21 credits beyond the master’s degree (or 37 credits beyond the bachelor’s degree) must be earned in courses numbered 500 or above.
- Ph.D. students are required to take two structured courses per academic year. Students must register for the courses, and only one may be taken as an audit. The structured courses can be selected from the 500, 600, or 700 level. With written advisor approval, the courses may also include structured graduate classes from other departments. When the student is within one semester of graduation, the student and advisor may petition the Department Head, in writing, for a waiver of the “two courses per year” requirement. While ATS 784 (Supervised College Teaching) is not considered a structured academic course, it is allowed to count towards the two courses per academic year Ph.D. requirement.
- Successful completion of ATS 693 (1 cr), Responsible Conduct of Research, offered every spring semester.
- Audits count towards the department’s requirement that all GRA’s enroll for at least 15 credit hours each semester (section L). But audits do not count towards the total required course credits for the Ph.D., and may not be listed on the GS Form 6.

**Evaluation Mechanisms**

- Successful research topic proposal presentation
- Dissertation prepared under the mentorship of the student’s advisor and graduate committee that meets the following criteria: displays original and creative scholarship, contributes new knowledge to the field of atmospheric science, and expresses good literate style.
- Successful defense of a dissertation before the student’s graduate committee and any other members of the academic and scientific communities who desire to attend

The student’s Graduate Committee is charged with ensuring the student gains breadth in Atmospheric Science during his/her tenure in the program. Accordingly the Graduate Committee may make recommendations on coursework to be completed prior to graduation.

**Courses**

**Atmospheric Science (ATS)**

ATS 150  Science of Global Climate Change  Credits: 3 (3-0-0)

**Course Description:** Physical basis of climate change. Energy budget of the earth, the greenhouse effect, carbon cycle, paleoclimate, projections of 21st-century climate.

- **Prerequisite:** None.
- **Term Offered:** Spring.
- **Grade Mode:** Traditional.
- **Special Course Fee:** No.

ATS 350  Introduction to Weather and Climate  Credits: 2 (2-0-0)

**Course Description:** Behavior of atmosphere and its influence upon human’s activities.

- **Prerequisite:** None.
- **Term Offered:** Fall.
- **Grade Mode:** Traditional.
- **Special Course Fee:** No.

ATS 351  Introduction to Weather and Climate Laboratory  Credit: 1 (0-3-0)

**Course Description:** Actual weather data, visualization of meteorological phenomena, in-depth discussion of current environmental issues.

- **Prerequisite:** ATS 350, may be taken concurrently.
- **Term Offered:** Fall.
- **Grade Mode:** Traditional.
- **Special Course Fee:** No.

ATS 495  Independent Study  Credits: Var[1-18]

**Course Description:**

- **Prerequisite:** None.
- **Terms Offered:** Fall, Spring, Summer.
- **Grade Mode:** Instructor Option.
- **Special Course Fee:** No.

ATS 543  Current Topics in Climate Change  Credits: 2 (2-0-0)

**Course Description:** Climate fundamentals and current topics in climate change.

- **Prerequisite:** BZ 300 to 499 or ECOL 300 to 499 or LIFE 300 to 499 or CHEM 300 to 499.
- **Registration Information:** Credit not allowed for both ATS 543 and ESS 543. Sections may be offered: Online.
- **Term Offered:** Fall.
- **Grade Mode:** S/U Sat/Unsat Only.
- **Special Course Fee:** No.
ATS 555  Air Pollution  Credits: 3 (3-0-0)
Course Description: Nature, ambient concentrations, sources, sinks, and physiological activities of pollutants; meteorology; legislation; social and economic factors.
Prerequisites: (CHEM 113) and (MATH 261 or MATH 340) and (PH 122 or PH 142).
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 560  Air Pollution Measurement  Credits: 2 (1-3-0)
Course Description: Examination and application of techniques for air pollution measurement. Includes sampling and analysis of gases, aerosols, and precipitation.
Prerequisite: CHEM 114.
Registration Information: Must register for lecture and laboratory.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 601  Atmospheric Dynamics I  Credits: 3 (3-0-0)
Course Description: Momentum, continuity equations; circulation, vorticity, thermodynamics; boundary layer; synoptic scale motions in midlatitudes.
Prerequisites: MATH 261 and MATH 530.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 602  Atmospheric Dynamics II  Credits: 2 (2-0-0)
Course Description: Sound waves, gravity waves, Rossby waves; numerical weather prediction; baroclinic instability; general circulation; tropical dynamics.
Prerequisite: ATS 601.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 604  Atmospheric Modeling  Credits: 3 (3-0-0)
Course Description: Design of numerical models of the atmosphere; applications to current problems. Emphasis on practical understanding of relevant numerical methods.
Prerequisite: ATS 601.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 605  Atmospheric Circulations  Credits: 3 (3-0-0)
Course Description: Observations and theory of the general circulation of the atmosphere, with emphasis on understanding physical mechanisms.
Prerequisite: ATS 602, may be taken concurrently.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 606  Introduction to Climate  Credits: 3 (3-0-0)
Course Description: Exchange of energy, water, and momentum through the atmosphere, surface, vegetation, oceans. Paleoclimate, climate change, variability, and feedbacks.
Prerequisites: MATH 261 and MATH 530.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 607  Computational Methods for Atmospheric Science  Credits: 3 (3-0-0)
Course Description: Computer programming tools unique to and common in the atmospheric sciences.
Prerequisite: ATS 601, may be taken concurrently.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 610  Physical Oceanography  Credits: 3 (3-0-0)
Course Description: Foundations of ocean circulation theory and the general circulation of the oceans using observational data and rotating tank experiments.
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 620  Thermodynamics and Cloud Physics  Credits: 3 (3-0-0)
Course Description: Equilibrium thermodynamics, cloud microphysics, cloud dynamics, precipitation formation, and cloud electrification.
Prerequisites: MATH 340 and PH 142.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 621  Atmospheric Chemistry  Credits: 2 (2-0-0)
Course Description: Overview of chemical kinetics and equilibria; sources and sinks of pollutants; photochemistry and smog formation; aqueous-phase chemistry; acid rain.
Prerequisites: CHEM 114 and MATH 340 and PH 142.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 622  Atmospheric Radiation  Credits: 3 (3-0-0)
Course Description: Terrestrial, solar radiation propagation in the atmosphere; radiative components in energy budgets, weather systems, climate studies; remote sensing.
Prerequisite: ATS 620.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.
ATS 623  Atmospheric Boundary Layer  Credits: 2 (2-0-0)
Course Description: Equations for shallow atmospheric motions; thermal instability of a fluid layer; atmospheric turbulence; flow stability; 1-D mixed layer models.
Prerequisite: ATS 601, may be taken concurrently.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 631  Introduction to Atmospheric Aerosols  Credits: 2 (1-3-0)
Course Description: Physical, chemical and microphysical characteristics of atmospheric particulate matter; measurement principles and techniques.
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 640  Synoptic Meteorology  Credits: 3 (2-3-0)
Course Description: Synoptic-scale weather systems; moist and dry atmospheric variables; static stability; vertical motion; fronts; cyclones and anticyclones.
Prerequisite: ATS 601, may be taken concurrently.
Restriction: Must be a: Graduate, Professional.
Registration Information: Must register for lecture and laboratory.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 641  Mesoscale Meteorology  Credits: 3 (2-3-0)
Course Description: Mesoscale weather systems; mesoanalysis techniques; upper- and low-level jets; instabilities; dynamics of convective storms; organized convection.
Prerequisite: ATS 640.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 650  Measurement Systems and Theory  Credits: 2 (2-0-0)
Course Description: Surface and upper air measurement systems; theory and system response, sensor design; automated data collection, analysis and display systems.
Prerequisites: PH 142 and STAT 301.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 652  Atmospheric Remote Sensing  Credits: 2 (2-0-0)
Course Description: Concepts of electromagnetic and acoustic wave propagation; active and passive remote sensing techniques including radar, lidar, thermal emission systems.
Prerequisite: ATS 622.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 655  Objective Analysis in Atmospheric Sciences  Credits: 3 (3-0-0)
Course Description: Objective analysis of geophysical data: general statistics; matrix methods; time series analysis. Emphasis on applications to real-world data.
Prerequisite: MATH 530.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 659A  Independent Study: Atmosphere/Ocean Coupling  Credits: Var[1-18]
Course Description: Prerequisite: None.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 659B  Independent Study: Atmospheric Science Topics  Credits: Var[1-18]
Course Description: Prerequisite: None.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 659A  Thesis: Atmospheric Dynamics  Credits: Var[1-18]
Course Description: Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 659B  Thesis: Land-Atmosphere Interactions  Credits: Var[1-18]
Course Description: Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 659C  Thesis: Chemistry-Climate Interactions  Credits: Var[1-18]
Course Description: Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699G Thesis: General Circulation Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699I Thesis: Atmospheric Chemistry Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699K Thesis: Dynamic Meteorology Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699M Thesis: Mesoscale Meteorology Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699N Thesis: Dynamics and Physics of Clouds Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699O Thesis: Mesoscale Modeling Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699P Thesis: Radiation Theory Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699Q Thesis: Radar Meteorology Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699S Thesis: Climate Dynamics Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.
ATS 699T Thesis: Oceanography Credits: Var[1-18]
Course Description: None.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description: None.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 699V Thesis: Atmospheric Variability Credits: Var[1-18]
Course Description: None.
Restriction: Must be a: Graduate.
Term Offered: Fall, Spring, Summer.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 703 Numerical Weather Prediction Credits: 2 (2-0-0)
Course Description: Quasi-geostrophic approximation; barotropic, baroclinic, primitive equation, and general circulation models; numerical methods.
Prerequisite: ATS 602.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 704 Large-Scale Atmospheric Dynamics Credits: 2 (2-0-0)
Course Description: Quasi-static, quasi-geostrophic equations; planetary waves; geostrophic adjustment; barotropic, baroclinic instability; frontogenesis; tropical cyclones.
Prerequisite: ATS 602.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 707 Atmospheric Waves and Vortices Credits: 3 (2-0-1)
Course Description: Atmospheric wave motions and embedded vortices spanning mountain waves to large-scale Rossby waves and critical layers.
Prerequisite: ATS 605.
Restriction: Must be a: Graduate, Professional.
Registration Information: Must register for lecture and recitation.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 708 Middle Atmospheric Dynamics Credits: 3 (3-0-0)
Course Description: Dynamics of the stratosphere and mesosphere with emphasis on the lower and middle stratosphere.
Prerequisite: ATS 602.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 710 Geophysical Vortices Credits: 3 (3-0-0)
Course Description: Observational, experimental, and theoretical aspects of geophysical vortices, such as hurricanes, polar lows, tornadoes, and dust devils.
Prerequisite: ATS 602.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 711 Microclimate Credits: 2 (2-0-0)
Course Description: Momentum, heat, water, and trace gas fluxes near the earth's surface, including fluxes between the atmosphere and the land/ocean/ice surfaces.
Prerequisites: MATH 340 and ATS 623.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 712 Dynamics of Clouds Credits: 3 (3-0-0)
Course Description: General theory of cloud dynamics; parameterization of microphysics and radiation; models of fog, stratocumuli, cumulonimbus, and orographic clouds.
Prerequisite: ATS 623.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 715 Atmospheric Oxidation Processes Credits: 2 (2-0-0)
Course Description: Atmospheric hydrocarbon and nitrogen oxide reactions; aqueous phase scavenging and reactions; chemical pathways in the atmosphere.
Prerequisite: ATS 621.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 716 Air Quality Characterization Credits: 2 (1-2-0)
Course Description: Planning, executing, and reporting on a measurement campaign to characterize local air quality.
Prerequisites: (ATS 560) and (ATS 555 or ATS 621).
Restriction: Must be a: Graduate, Professional.
Registration Information: Must register for lecture and laboratory.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 721 Theoretical Topics in Radiative Transfer Credits: 3 (3-0-0)
Course Description: Physics of atmospheric radiation; theoretical techniques used to show radiation transfer equation.
Prerequisite: ATS 622.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.
ATS 722 Atmospheric Radiation and Energetics Credits: 3 (2-0-1)
Course Description: Radiative transfer in the atmosphere; implications on remote sensing and energetics.
Prerequisite: ATS 622.
Restriction: Must be a: Graduate, Professional.
Registration Information: Must register for lecture and recitation.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 724 Cloud Microphysics Credits: 2 (2-0-0)
Course Description: Theories and observations of nucleation; cloud droplet spectra broadening; precipitation growth and breakup; ice multiplication; cloud electrification.
Prerequisite: ATS 621.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 730 Mesoscale Modeling Credits: 3 (3-0-0)
Course Description: Development of basic equations used in mesoscale models and methodology of solution
Prerequisite: ATS 622 and ATS 623.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 735 Mesoscale Dynamics Credits: 3 (3-0-0)
Course Description: Analysis of physical and dynamical processes that initiate, maintain, and modulate atmospheric mesoscale phenomena.
Prerequisite: ATS 602.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 737 Satellite Observation of Atmosphere and Earth Credits: 3 (3-0-0)
Course Description: Satellite measurements; basic orbits and observing systems; applications of remote probing and imaging to investigations of atmospheric processes.
Prerequisite: ATS 622 and ATS 652.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 741 Radar Meteorology Credits: 3 (3-0-0)
Course Description: Radar systems; radar equation and applications; multiple Doppler observation and processing; radar studies of mesoscale systems.
Prerequisite: ATS 652.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 742 Tropical Meteorology Credits: 2 (2-0-0)
Course Description: Overview of the tropical atmosphere, monsoons, intraseasonal variability, hurricanes, theory of tropical convection and the large-scale circulation.
Prerequisites: ATS 601 and ATS 602 and ATS 606.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 743 Interactions of the Ocean and Atmosphere Credits: 3 (3-0-0)
Course Description: Ocean-atmosphere interactions in observations, theory, and models. Time mean atmosphere-ocean circulations through climate variability and change.
Prerequisite: ATS 602.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 745 Atmospheric General Circulation Modeling Credits: 3 (3-0-0)
Course Description: Current problems in modeling of the general circulation of the atmosphere.
Prerequisites: ATS 602 and ATS 605.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 750 Climate Dynamics: Atmospheric Variability Credits: 3 (3-0-0)
Course Description: Analysis and interpretation of large-scale patterns of climate variability and observed climate change.
Prerequisites: ATS 605 and ATS 655.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 752 Inverse Methods in Atmospheric Science Credits: 2 (2-0-0)
Course Description: Introduction to inverse modeling, with particular application to remote sensing retrievals, flux inversions and data assimilation.
Prerequisite: None.
Registration Information: Ph.D. standing in Atmospheric Science required.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

ATS 753 Global Hydrologic Cycle Credits: 3 (3-0-0)
Course Description: Hydrologic cycle, moisture transport and air-ground exchange; water budgets of meteorological phenomena; climatology of atmospheric water.
Prerequisites: (ATS 601) and (ATS 622 or ATS 652).
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.
ATS 755 Theoretical and Applied Climatology Credits: 3 (3-0-0)
Course Description: Current topics in climate research.
Prerequisite: ATS 606.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 760 Global Carbon Cycle Credits: 2 (2-0-0)
Course Description: Exchanges of CO₂ between the atmosphere, the land surface, and oceans. Biogeochemical processes. Micrometeorological and inverse flux estimation.
Prerequisite: ATS 606.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 761 Land-Atmosphere Interactions Credits: 2 (2-0-0)
Course Description: Exchange of energy, water, momentum, and carbon between the land surface and the atmosphere.
Prerequisite: ATS 606.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 762 Biosphere-Chemistry-Climate Interactions Credits: 2 (2-0-0)
Course Description: Explore the sensitivity of the climate system to atmospheric chemical composition with emphasis on connections to biospheric processes and feedbacks.
Prerequisite: ATS 606.
Restriction: Must be a: Graduate, Professional.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 765 Climate Dynamics-Ocean Variability Credits: 3 (3-0-0)
Course Description: Climate variability on time scales of years to millennia with focus on the role of the ocean circulation. Approach through dynamical systems theory.
Prerequisite: ATS 606.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 770 Ocean Modeling Credits: 3 (3-0-0)
Course Description: Conceptual and numerical ocean models and their application to current problems in climate science and biogeochemical cycles.
Prerequisite: ATS 601.
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 772 Aerosol Chemistry Credits: 2 (2-0-0)
Course Description: Physics and chemistry of atmospheric aerosols including composition, surface properties, size, interaction with radiation sources, sinks.
Prerequisites: (CHEM 114 and MATH 161) and (PH 122 or PH 142).
Restriction: Must be a: Graduate, Professional.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

ATS 784 Supervised College Teaching Credits: Var[1-18]
Course Description: 
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 786 Practicum Credits: Var[1-18]
Course Description: 
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 795 Independent Study Credits: Var[1-18]
Course Description: 
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 796 Group Study Credits: Var[1-18]
Course Description: 
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799A Dissertation: Atmospheric Dynamics Credits: Var[1-18]
Course Description: 
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799B Dissertation: Land-Atmosphere Interactions Credits: Var[1-18]
Course Description: 
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.
ATS 799C  Dissertation: Chemistry-Climate Interactions  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799E  Dissertation: Remote Sensing  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799F  Dissertation: Ocean-Atmosphere Interactions  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799G  Dissertation: General Circulation  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799H  Dissertation: Remote Sensing of Climate  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799I  Dissertation: Atmospheric Chemistry  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799J  Dissertation: Aerosol and Cloud Microphysics  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799K  Dissertation: Dynamic Meteorology  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799L  Dissertation: Satellite Applications  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799M  Dissertation: Mesoscale Meteorology  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799N  Dissertation: Dynamics and Physics of Clouds  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799O  Dissertation: Mesoscale Modeling  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799P  Dissertation: Radiation Theory  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799Q  Dissertation: Radar Meteorology  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799R  Dissertation: Aerosol and Cloud Chemistry  Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.
ATS 799S Dissertation: Climate Dynamics Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799T Dissertation: Oceanography Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799U Dissertation: Tropospheric Chemistry Credits: Var[1-18]
Course Description:
Prerequisite: None.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

ATS 799V Dissertation: Atmospheric Variability Credits: Var[1-18]
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.